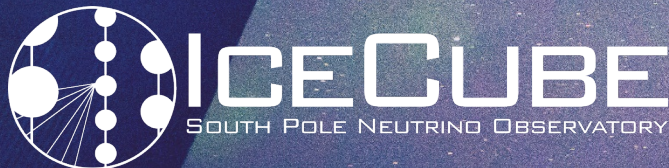


IceCube A-333 Fieldwork Plans

Kael Hanson and the IceCube M&O Team

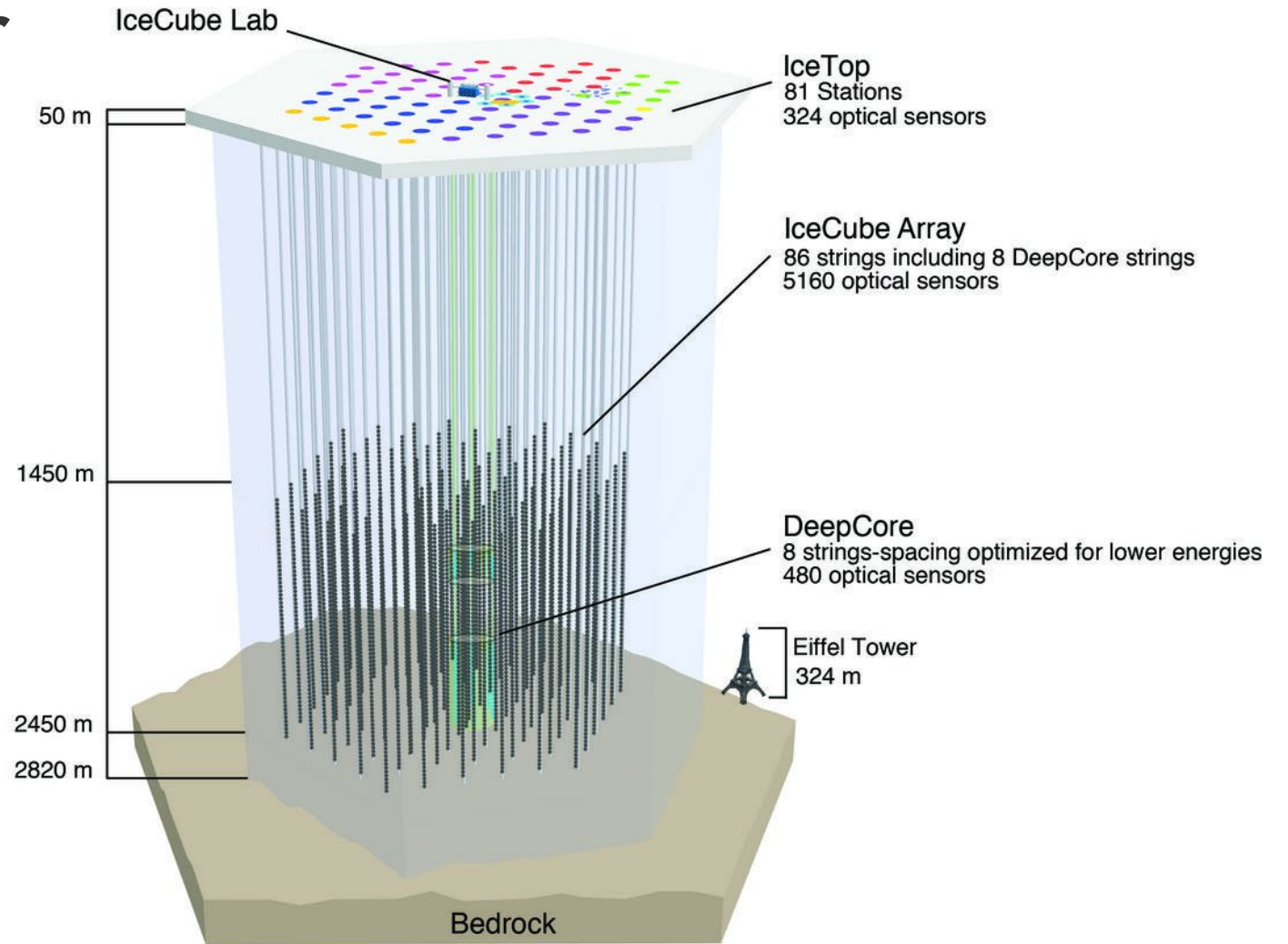
IceCube Management and Operations
NSF Field Work Planning March 18, 2020



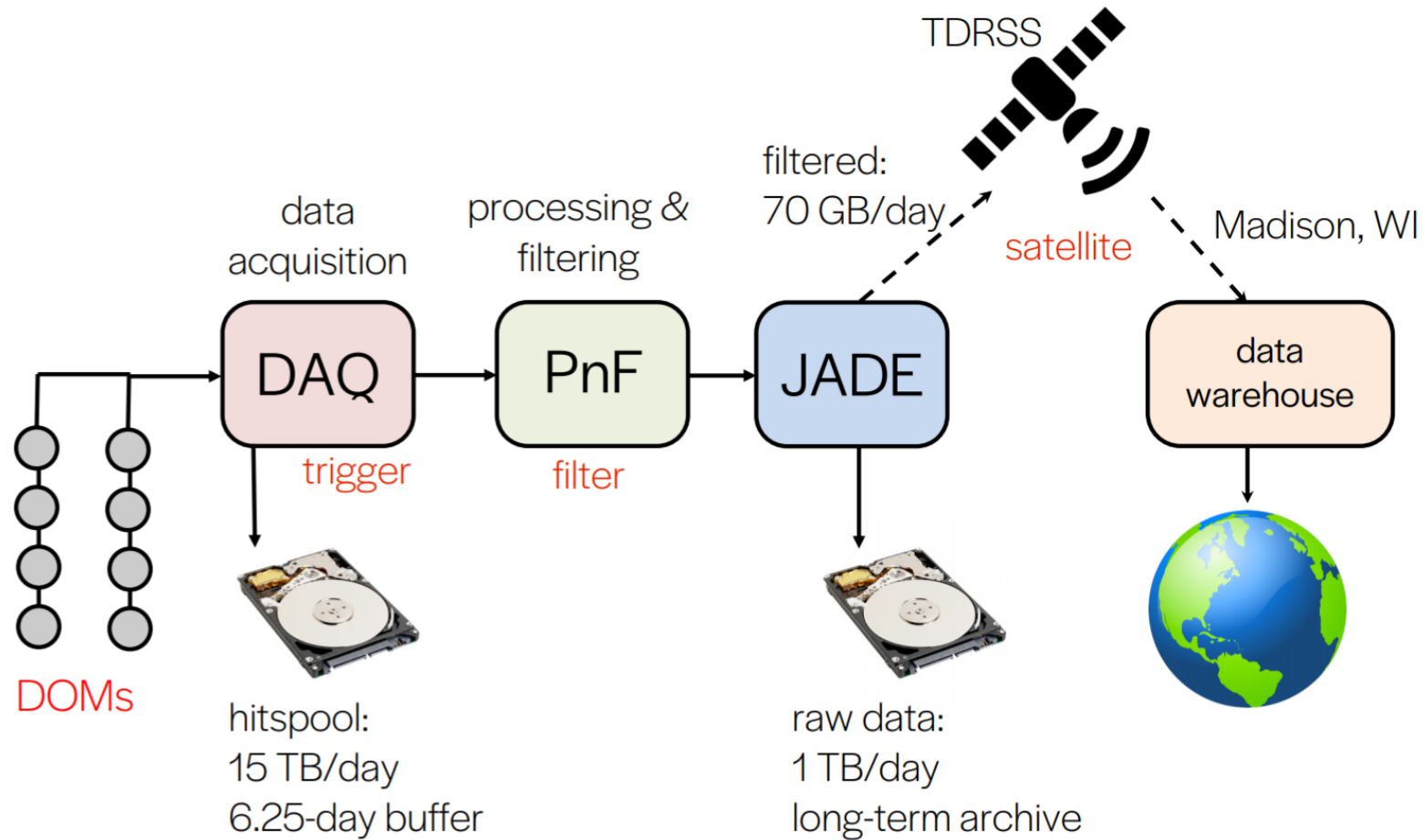
Outline

- The IceCube detector online systems.
- Remote operation + needs for / benefits of 24/7 medium B/W satellite (Iridium NEXT)
- Detector maintenance activities
- Scintillator / surface / ARA detectors
- Description of field seasons
- Gen2 preparations – see Albrecht's presentation

The IceCube Detector



Online Systems Overview (J. Kelley)



IceCube Live / IceCube Remote Access

- IceCube online systems designed to be as autonomous as possible to facilitate remote operation.
 - Continuous automatic monitors of data flow / automatic crash detection
 - Automatic recovery from many serious hardware failure modes possible
 - Winter-over paging / detector ops team alerts automated.
- Login via ssh to Linux (most developers use this channel)
- IceCube Live: South Pole + near-real-time mirror in North
 - Status dashboard – what is currently going on? Are there problems?
 - Database of historical detector metadata
 - Detector monitoring tool
 - Run info (good/bad/etc); individual channel historical info including channel hardware issues; history of alerts; weather information; much more ...



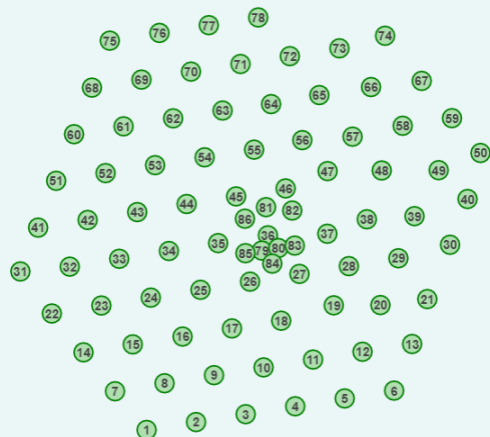
Data Acquisition

133854 **RUNNING** 3h 51m
Current run pDAQ state Duration

Urban_Harvest9 38,823,989 dark
pDAQ release Event count LID mode

Full Start 5408 / 5408
Transition Active DOMs

sps-IC86-2019-no-sm...o-Reliant_Robin-V288
Run configuration



Components

I3DAQDispatch **RUNNING** PFDSTWriter **RUNNING**

PFFiltWriter **RUNNING** PFMoniWriter1 **RUNNING**

PFMoniWriter2 **RUNNING** PFMoniWriter3 **RUNNING**

PFMoniWriter4 **RUNNING** PFOneWriter **RUNNING**

PFRawWriter **RUNNING** PFServer1 **RUNNING**

PFServer2 **RUNNING** PFServer3 **RUNNING**

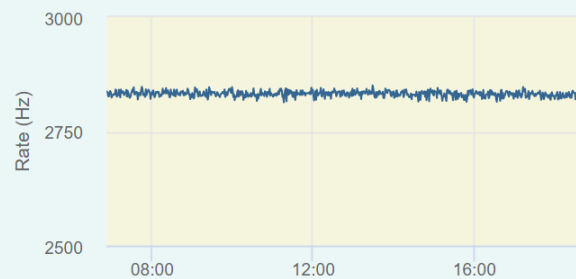
PFServer4 **RUNNING** PFServer5 **RUNNING**

PFServer6 **RUNNING** PFServer7 **RUNNING**

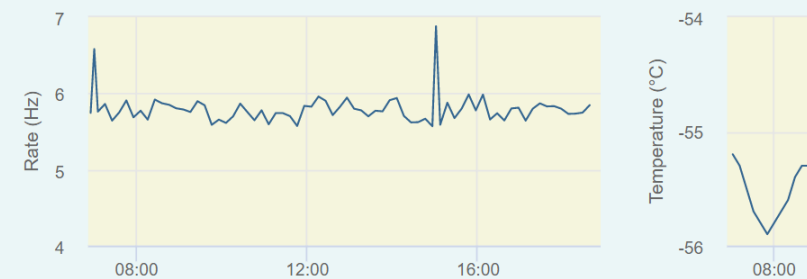
Live Alerts

- FPMaster disk usage too high
- Too much time betw...DAQ latency messages
- Current run config is not primary
- Detector not taking data
- Excessive run failure rate
- I3DAQDispatch is not RUNNING
- I3MS link is not UP
- Modem ttyS1 is unable to connect
- Modem ttyS4 is unable to connect
- Modem ttyS6 is unable to connect
- Modem ttyS7 is unable to connect
- Multirunfail
- PFDSTWriter is not RUNNING
- PFFiltWriter is not RUNNING
- PFRawWriter is not RUNNING
- PFServer1 is not RUNNING
- PFServer2 is not RUNNING
- PFServer3 is not RUNNING
- PFServer4 is not RUNNING
- PFServer5 is not RUNNING
- PFServer6 is not RUNNING
- PFServer7 is not RUNNING
- PFServer8 is not RUNNING
- PnF file backlog too large
- PnF rate too low
- PPP link is not UP
- Runfail
- SERIOUS SN alert triggered!
- SNDAQ is not RUNNING
- SNDAQ latency too high
- Throttling messages from noisy service
- Too many *.dat file...local/pdaq/sndaq/tmp
- Too many *.sn.tar fi... /mnt/data/pdaqlocal

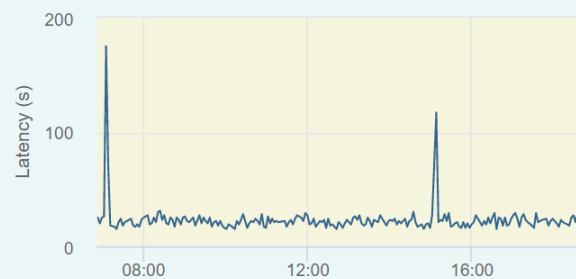
Event Rate



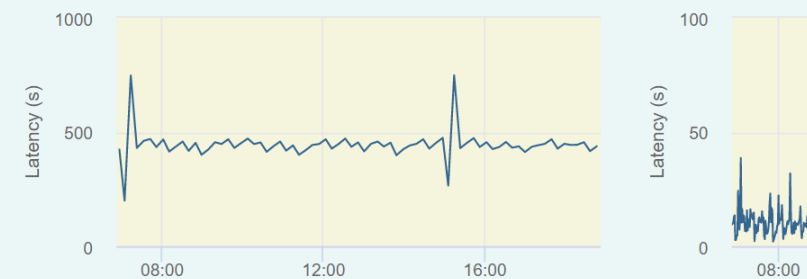
Neutrino Candidate Rate



Filtering Latency



Supernova DAQ Latency



Component Alerts

No alerts in past 24h

- hubmoni 1d 8h 52m ago
ithub11: unexpected number of DOMs
- hubmoni 1d 8h 52m ago
ithub11: DOM power check failure
- hubmoni 6d 2h 28m ago
ichub09: unexpected number of DOMs
- PFServer5-loop 6d 21h 17m ago
component crash
- PFClient.fpslave06.client28-loop 6d 21h 50m ago
component crash
- PFClient.fpslave09.client12-loop 6d 21h 50m ago
component crash
- PFClient.fpslave05.client36-loop 6d 21h 50m ago
component crash
- PFClient.fpslave05.client12-loop 6d 21h 50m ago
component crash
- PFClient.fpslave02.client4-loop 6d 21h 50m ago

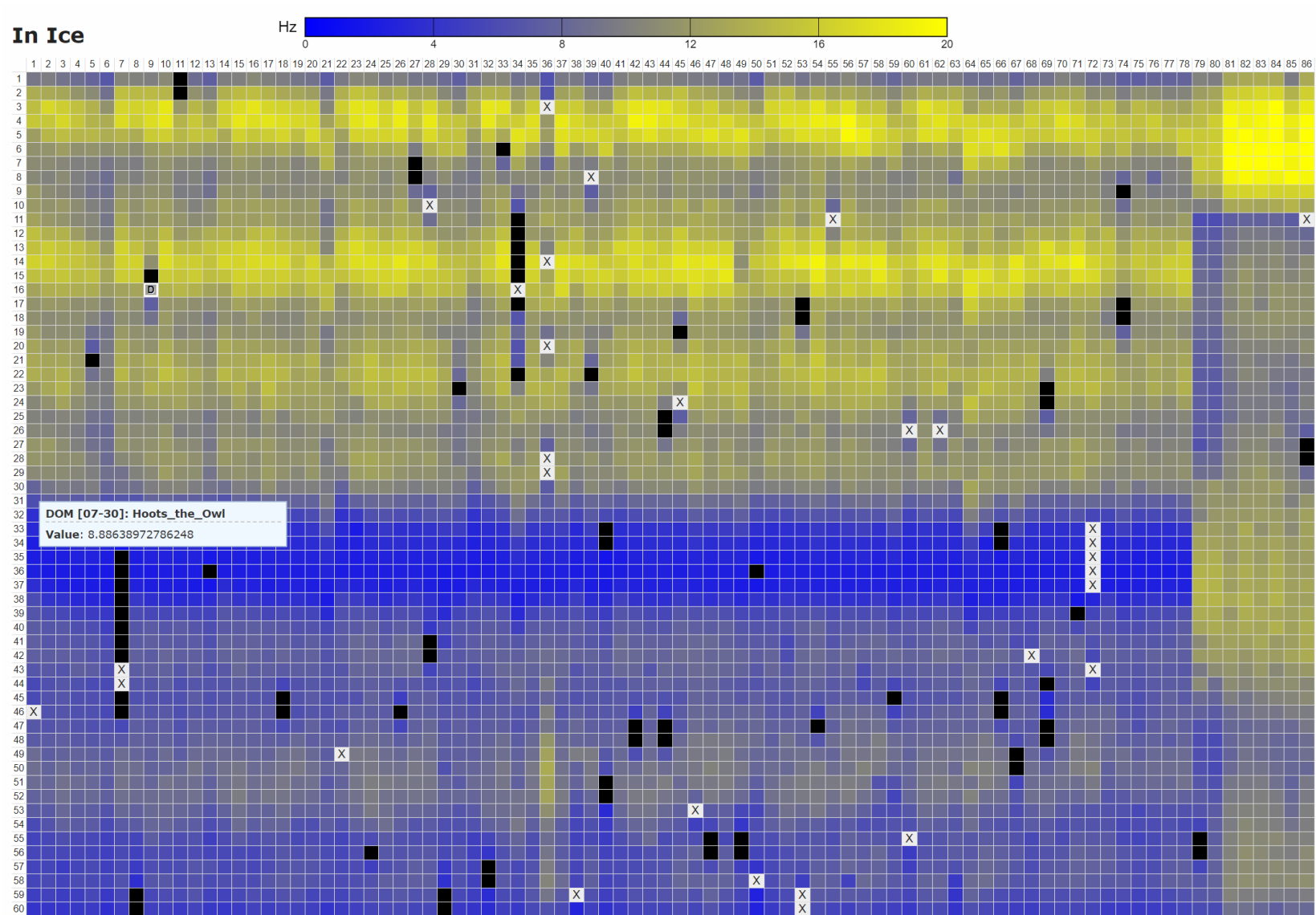
Recent Log Msgs

```

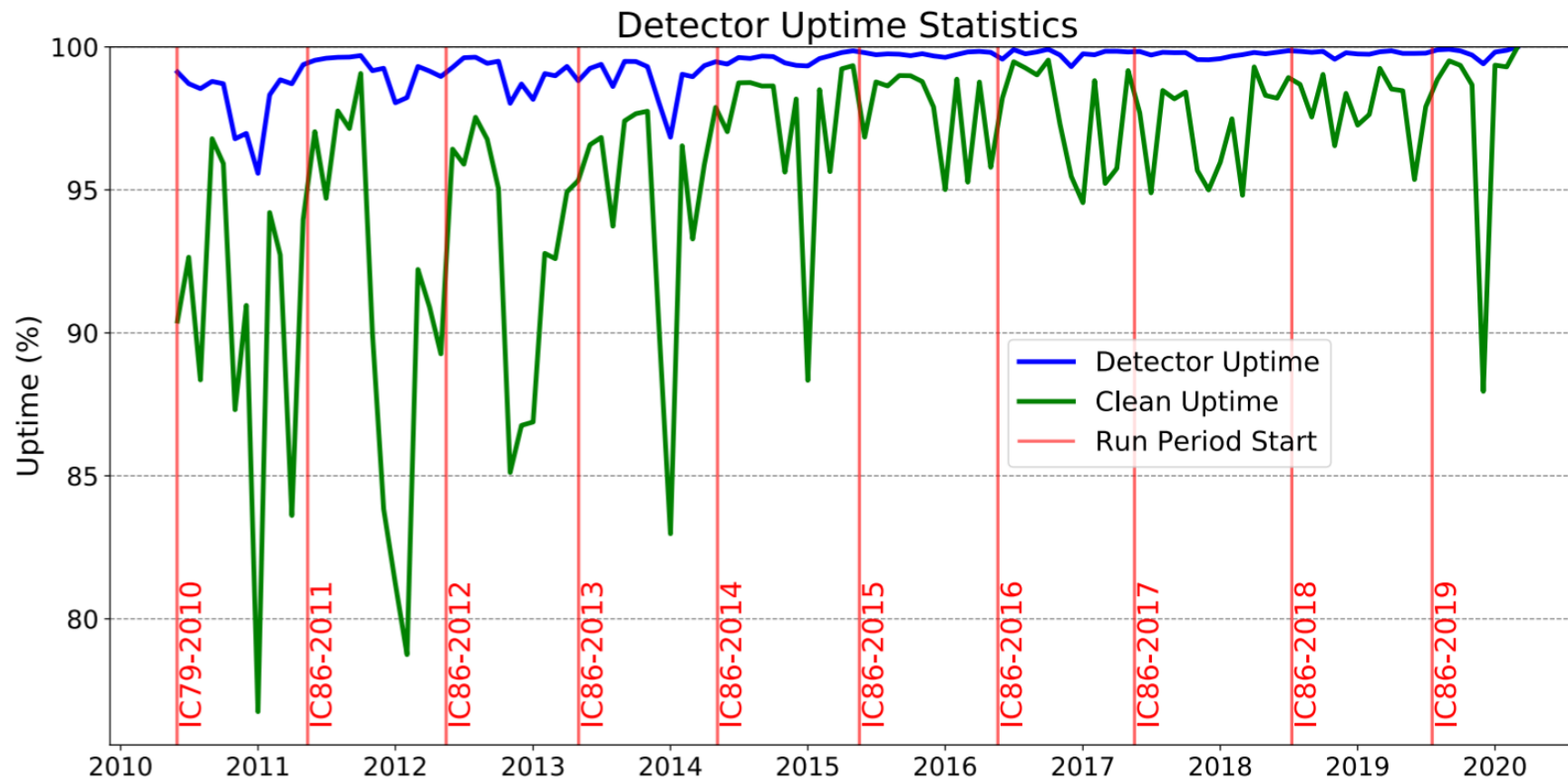
2020-03-17 15:01:45 Using system time for initial event counts (no event times available)
2020-03-17 15:01:37 Starting run 133854...
2020-03-17 15:01:36 Cluster: sps-cluster
2020-03-17 15:01:36 Run configuration: sps-IC86-2019-no-smt1-no-Reliant_Robin-V288
2020-03-17 15:01:36 Version info: Urban_Harvest9 16608:179348 2020-03-09 18:59:30
2020-03-17 15:01:36 pdaq: STOPPED -> start {'runNumber': 133854, 'subRunNumber': 0, 'runConfig': 'sps-IC86-2019-no-smt1-no-Reliant_Robin-V288'}
2020-03-17 15:00:56 Wrote combined log for run 133853
2020-03-17 15:00:55 Writing combined log for run 133853
2020-03-17 15:00:54 Run terminated SUCCESSFULLY.
2020-03-17 15:00:54 81618254 physics events collected in 28810 seconds (2832.98 Hz)
2020-03-17 15:00:45 pdaq: RUNNING -> stop
2020-03-17 07:00:57 Wrote combined log for run 133852
2020-03-17 07:00:43 Writing combined log for run 133852
2020-03-17 07:00:42 Run switched SUCCESSFULLY.
2020-03-17 07:00:42 81653341 physics events collected in 28810 seconds (2834.20 Hz)
2020-03-17 07:00:36 Switching to run 133853...
2020-03-17 07:00:36 Cluster: sps-cluster
2020-03-17 07:00:36 Run configuration: sps-IC86-2019-no-smt1-no-Reliant_Robin-V288
2020-03-17 07:00:36 Version info: Urban_Harvest9 16608:179348 2020-03-09 18:59:30
2020-03-17 07:00:35 pdaq: RUNNING -> switchrun {'runNumber': 133853, 'subRunNumber': 0, 'runConfig': 'sps-IC86-2019-no-smt1-no-Reliant_Robin-V288'}
2020-03-16 23:00:47 Wrote combined log for run 133851
2020-03-16 23:00:35 Writing combined log for run 133851
2020-03-16 23:00:33 Run switched SUCCESSFULLY.
2020-03-16 23:00:33 81665773 physics events collected in 28807 seconds (2834.93 Hz)
2020-03-16 23:00:28 Switching to run 133852...

```

Detector monitoring
example from
recent run



IceCube Detector Uptime Fraction



KPP for IceCube. Blue line typically 99.8% represents fraction of time some (usually most) of IceCube online. Green line indicates fraction of perfect 100% online run time.



Field Maintenance Activities of the IceCube Detector

Daily | Monthly | Yearly

Inside the ICL



- 18 racks of equipment
- 97 DOMHubs (1 / string + IceTop)
 - low-power single-board computers
 - custom DOM readout and clock fanout cards
 - DOM power supplies
- ~40 Dell PowerEdge servers
 - DAQ, PnF, infrastructure
- GPS receivers + fanouts, network switches, UPS, special devices

Implications of 24/7, medium B/W Satellite

- 24/7 internet connectivity limited to 2.4 kbit/sec/modem Iridium link.
- Makes rapid development / debugging from North nearly impossible.
- Faster 24/7 link could reduce required population at Pole
 - DAQ development / maintenance / WO training
 - Detector calibration runs (e.g., flasher runs)
- Perhaps other science groups would also be able to reduce pop → overall significant station population reduction
- Other, beneficial side effects:
 - IceCube Live becomes even more live /w/ richer more interactive content
 - Easier communications with Winter-Over operators.

A photograph of a snowy landscape at sunset. The sun is low on the horizon, casting a warm glow over the scene. In the distance, several flags on poles are visible against the sky. The foreground is dominated by the undulating, rippled surface of the snow, which is illuminated by the low sun, creating a mix of blue and white tones.

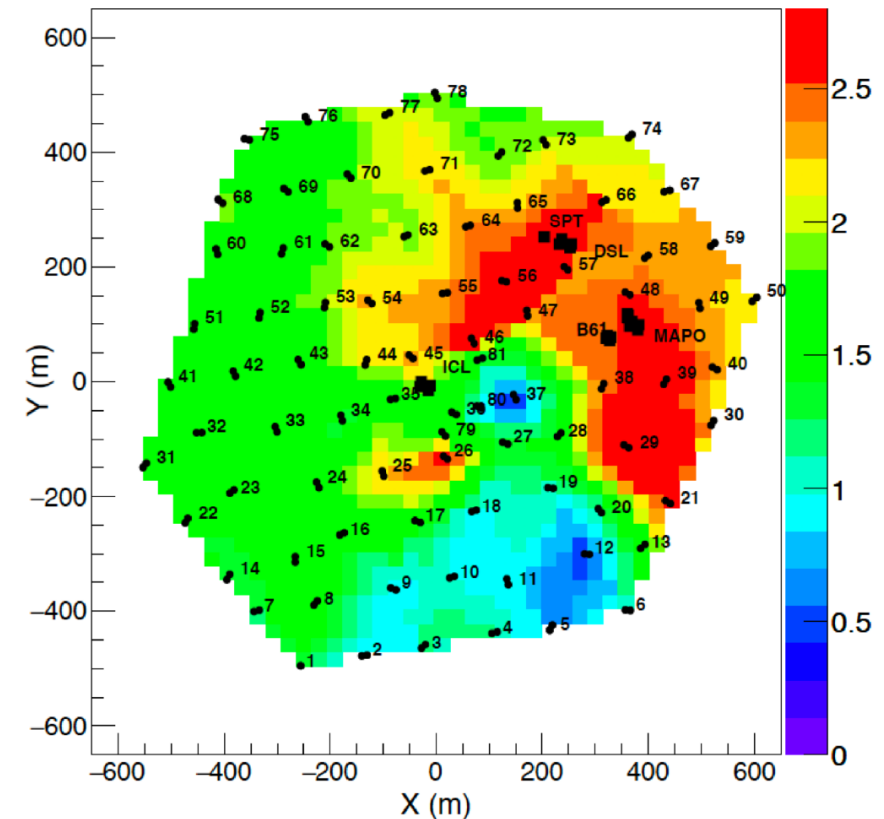
Ancillary IceCube Detector Elements

Scintillators, ARA, Surface Radio

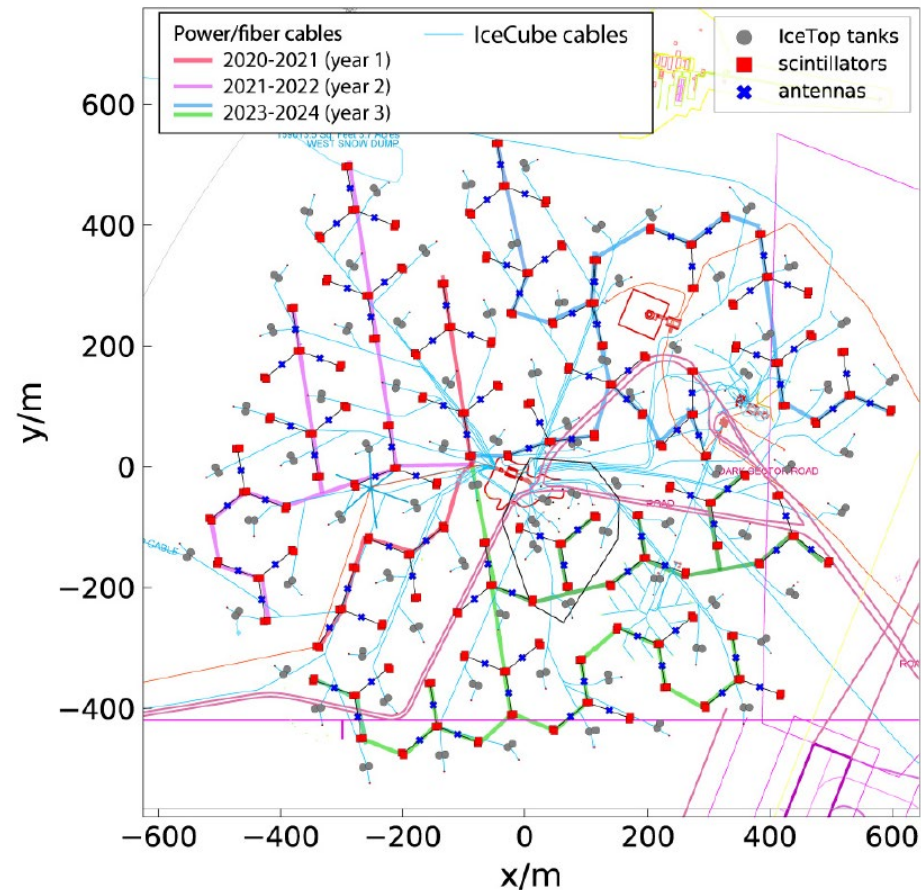
Scintillators and Cosmic Ray Radio

- 2014 support contractor ceased snow maintenance around IceTop tanks. Agreement to mitigate snow coverage by installation of scintillators.
- Snow accumulation leads to increased energy threshold and greater systematic errors for IceTop cosmic ray veto performance.

Snow Depth on IceTop tanks Oct/2016



Scintillator Installation Plan



- Map at left shows installation plan.
- Plan has changed – no installation of new equipment in 20/21 season. Other seasons rolled into next cycle of IceCube M&O and stretched out over more seasons to alleviate logistics.

season	#stations (up to)	cargo [lbs]	trenching [km]	highest pop
2020-21	1	1k	0.5	3 (3 weeks)
2021-22	5	9k	1.4	5 (3 weeks)
2022-23	0	0	0	0
2023-24	7	12.6k	2.4	5 (2.5 weeks)
2024-25	9	16.2k	3	5 (3 weeks)
2025-26	10	18k	2.8	5 (3.5 weeks)

ARA Station Maintenance

- As of 2019 IceCube M&O has subsumed operations of the 5 Askar'yan Radio Array (ARA) stations in *de minimis* fashion.
- In description of field seasons that follow, there is no dedicated cargo nor personnel for ARA maintenance activities, rather rolled into some combination of Winter-Overs and/or DAQ/Engineering.

Field Season 2020-2021

IceCube (333)	Types/items of fieldwork	Southbound cargo projection		Projected Population Profile (max per day in a half-month)						
Work Item number	Enter here what is absolutely needed (in black) for the subject season, "good to be accomplished" (in blue), or what the project envisions (in red - even not yet funded activities)	Weight (lbs)	Cubic Feet	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31	Jan 1-15	Jan 16-31	Feb 1-15
	Austral summer season FY 2021 (2020-2021)	3550	384	4	5	7	7	6	7	2
1	Winterovers			2	2	2	2	2	2	2
2	Computing and hub maintenance	2000	128	1	1	3	3			
3	Calibration	150	32		1	1	1			
4	DAQ/ Engineering support	150	32	1	1	1	1	1	1	
5	Scintillator / radio maintenance	1000	128					3	3	
6	IceACT maintenance	250	64						1	

Minimal M&O season – scintillator plan to deploy 4 stations cut to maintenance of 1 station. Retro / cleanup of major computing lifecycle replacement in 19/20 season.

Field Season 2021-2022

IceCube (333)	Types/items of fieldwork	Southbound cargo projection		Projected Population Profile (max per day in a half-month)						
Work Item number	Enter here what is absolutely needed (in black) for the subject season, "good to be accomplished" (in blue), or what the project envisions (in red - even not yet funded activities)	Weight (lbs)	Cubic Feet	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31	Jan 1-15	Jan 16-31	Feb 1-15
	Austral summer season FY 2022 (2021-2022)	14550	1033	6	8	8	8	8	8	2
1	Winterovers			2	2	2	2	2	2	2
2	Computing and hub maintenance	3500	256	1	2	2	2			
3	Calibration	150	32		1	1				
4	DAQ/ Engineering support	150	32	1	1	1	1	1	1	
5	M&O Upgrade support	1500	256	2	2	2	2			
6	Scintillator installation	7000	253				1	4	3	
7	Radio installation	2000	140					1	1	
8	IceACT maintenance	250	64						1	

Activities:

- Scintillator station installation
- Minor ICL infrastructure upgrade to support integration of Upgrade instrumentation

Field Season 2022-2023

IceCube (333)	Types/items of fieldwork	Southbound cargo projection		Projected Population Profile (max per day in a half-month)						
Work Item number	Enter here what is absolutely needed (in black) for the subject season, "good to be accomplished" (in blue), or what the project envisions (in red - even not yet funded activities)	Weight (lbs)	Cubic Feet	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31	Jan 1-15	Jan 16-31	Feb 1-15
	Austral summer season FY 2023 (2022-2023)	4300	384	5	7	7	7	7	7	2
1	Winterovers			2	2	2	2	2	2	2
2	Computing and hub maintenance	3500	256	1	1	1				
3	Calibration	150	32				1	1	1	
4	DAQ / Engineering support	150	32	1	1	1	1	1	1	
5	M&O Upgrade support	500	64	1	3	3	3	3	3	

M&O activities cut to bare minimum to provide room for Upgrade population which is at maximum during this season for drilling and Upgrade string installation.

Field Season 2023-2024

IceCube (333)	Types/items of fieldwork	Southbound cargo projection		Projected Population Profile (max per day in a half-month)						
Work Item number	Enter here what is absolutely needed (in black) for the subject season, "good to be accomplished" (in blue), or what the project envisions (in red - even not yet funded activities)	Weight (lbs)	Cubic Feet	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31	Jan 1-15	Jan 16-31	Feb 1-15
	Austral summer season FY 2024 (2023-2024)	22900	1212	4	8	9	9	9	9	2
1	Winterovers			2	2	2	2	2	2	2
2	Computing and hub maintenance	9000	512	1	3	3	2			
3	Calibration	150	32		2	2	1	1	1	
4	DAQ/ Engineering support	150	32	1	1	1	1	1		
5	Scintillator installation	9800	312				2	4	4	
6	Radio installation	2800	196					1	1	
7	IceACT maintenance	250	64						1	
8	DOMHub replacement	750	64			1	1			

Activities:

- Begin major upgrade of IceCube readout computers (some in operation for 20 years!)
- Calibration runs / data processing for new calibration instrumentation installed in Upgrade.
- Scintillator install

Field Season 2024-2025

IceCube (333)	Types/items of fieldwork	Southbound cargo projection		Projected Population Profile (max per day in a half-month)						
Work Item number	Enter here what is absolutely needed (in black) for the subject season, "good to be accomplished" (in blue), or what the project envisions (in red - even not yet funded activities)	Weight (lbs)	Cubic Feet	Nov 1-15	Nov 16-30	Dec 1-15	Dec 16-31	Jan 1-15	Jan 16-31	Feb 1-15
	Austral summer season FY 2025 (2024-2025)	358692	1535	5	9	9	11	11	10	2
1	Winterovers			2	2	2	2	2	2	2
2	Computing and hub maintenance	6500	384	2	2	2	2			
3	Calibration	150	32		1	1	1	1	1	
4	DAQ/ Engineering support	150	32	1	1	1	1	1	1	
5	Scintillator installation	12600	371				2	4	4	
6	Radio installation	3600	252					1	1	
7	IceACT maintenance	250	64						1	
8	DOMHub replacement	3750	400		3	3	3	2		
9	Gen2 Construction PS1 (Preparation)	330000		10	20	20	20	20	10	

Activities:

- Finish hub upgrade
- Scintillator install
- Gen2 pre-season #1